Governance through expectations: examining the long-term policy relevance of smart meters in the United Kingdom

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Abstract

Socio-technical futures and associated expectations are acknowledged to play a crucial role in generating momentum for many science and technology innovations. Past research has mainly concentrated on studying the role of expectations within the early developments of innovations, formulated by technological developers and scientists, rather than looking at their role within policymaking. More recent work has started to address this gap, investigating the interrelations between expectations, the governance of innovations and policymaking. This paper examines the governance through expectations as formulated in policy documents and associated with the United Kingdom smart meter rollout over a 16-year period – between the policy consultation stage (2000–2008) and its more recent policy design stage (2009–2016). In doing so, it aims to contribute to the literatures on socio-technical futures, the sociology of expectations and smart meters by developing an understanding of how smart meters have been associated with a wider context of changing expectations within policy debates over time, and how policy has articulated, adjusted and attempted to stabilise expectations, whilst dealing with increasing scrutinisations of the rollout. We show that, even though the rollout has been highly contested, smart meters have maintained high policy relevance. This has been possible partly because expectations associated with smart meters have been broadened out and safeguarded by continually connecting them to the changing energy policy goals. Thus, smart meters and their future promises have been actively 'enacted'.

Keywords: Expectations, visions, smart meters, smart grid, United Kingdom, energy policy

1. Introduction

The United Kingdom (UK) Smart Meter Implementation Programme (SMIP) has been described as a monumental undertaking (Sovacool et al., 2017), and the most expensive and complex smart meter programme globally (Lewis and Kerr, 2014). Given that the main rollout only began in November 2016, its outcomes are uncertain. So far, the policy process has been far from smooth. Since 2010, some of the details of the rollout have been subjected to long negotiation periods (such as debating privacy, security and cost issues), causing the main installation period of the rollout (initially set to start in 2014) to be delayed three times. In 2015, the Energy and Climate Change Committee (2015b: 3) warned that '*without significant and immediate changes to the present policy, the programme runs the risk of falling far short of expectations'.* Considering this statement, interestingly, we found that smart meters have maintained their policy relevance in the UK over the last decade, even when other energy policy goals and instruments have changed. Policymakers have continued to place high expectations on the SMIP.

Future expectations play a crucial role in generating momentum for many science and technology innovations (e.g., Korsnes, 2016). Expectations have a performative role, presenting real-time visions of future socio-technological arrangements and envisioned social change that often initiate actions in the present (Brown et al., 2003; Borup et al., 2006; Porter and Randalls, 2014; Korsnes, 2016). Expectations therefore enable some innovations but also slow down or even disable others: *'they incite, block, justify'* (Brown et al., 2003: 3). Konrad (2006: 430) has argued that *'expectations channel efforts into certain directions and contribute to the emergence and stabilisation of sociotechnical structures*',

sometimes with the consequence of alternatives being neglected, potentially contributing to early path dependencies. Further, they are said to be constitutive '*in attracting the interest of necessary allies (such as innovation networks and regulatory actors, users, etc.) and defining roles and in building mutually binding obligations and agendas'* (Borup et al., 2006: 289).

Past research within this literature has mainly concentrated on studying '*expectations among researchers, industry actors, or media discourses'* (Budde and Konrad, 2015: 7) and associated with emerging technologies (van Merkerk and van Lente, 2005; Bakker et al., 2011; Boon et al., 2015; Kirkels, 2015), rather than being interested in their role within discourses in policy documents.[1] Budde and Konrad (2015) have argued that such neglect of policy discourses is peculiar, considering that many innovation activities intend to influence policymaking. More recent work has started to address this gap (Beynon-Jones and Brown, 2011; Berti and Levidow, 2014; Budde and Konrad, 2015; Melton et al., 2016), focusing on the role of policy in articulating and adjusting expectations for future technologies, i.e. governing of innovations through expectations. We build on this research by investigating expectations associated with smart meters during 2000–2016 within 38 energy and climate change policy documents and five parliamentary enquiry reports. In doing so, we complement both recent studies on smart meters that have largely focused on simulation (e.g., Rixen and Weigand, 2014; Zhang et al., 2016) and the growing literature on future expectations surrounding new technologies (Korsnes, 2016).

We will address the following empirical questions: How have expectations associated with the smart meter rollout changed in policy documents between the policy consultation stage (2000–2008) and its more recent policy design stage (2009–2016)? How has policy articulated, adjusted and attempted to stabilise expectations, whilst dealing with increasing scrutinisations surrounding the rollout?

Past research has mainly concentrated on studying the role of expectations within the early developments of innovations, formulated by technological developers and scientists, rather than looking at their role within policymaking. With this paper, we want to contribute to a better understanding of governance through expectations, drawing attention to studying expectations during the policy design phase of a technological rollout.

Section 2 provides a background of the smart meter rollout in the UK. Section 3 outlines the sociology of expectations literature, in particular the strand of it that is concerned with the governance through expectations, and Section 4 describes the methodological approach. Section 5 presents the findings, and Section 6 discusses them from the perspective of the sociology of expectations literature. Conclusions are presented in Section 7.

2. Background: The smart meter rollout in the United Kingdom

Smart meters have taken a prominent role in the UK government's domestic energy discourse during the past decade. Since 2006, driven by the European Union Energy End-Use Efficiency and Energy Services Directive, the successive governments have been busy debating which '*forms of metering, tariffing and billing are feasible'* (Darby, 2008: 70). The EU Directive 2006/32/EC mentioned technological innovation in 'electronic metering' and 'improved metering' but did not provide a specific definition. Article 13 stated that: "*Member States shall ensure that…final customers for electricity, natural gas, district heating*

[1] A topic that has received attention in other energy contexts, including bioenergy (Kivimaa and Mickwitz, 2011) and carbon capture and storage (Martinez Arrants, 2015), albeit not explicitly focused on expectations.

and/or cooling and domestic hot water are provided with competitively priced individual meters that accurately reflect the final customer's actual energy consumption and that provide information on actual time of use" (Directive 2006/32/EC). In 2008, after several government consultations and workshops, Gordon Brown's government announced its decision to rollout smart meters to all UK households by 2020. At the time, impact assessments surrounding the rollout and government-backed pilots to examine its benefits were still being conducted but this did not prevent an announcement of the rollout (Darby, 2009). This is in part due to EU requirements for Member States (in Directive 2009/72/EC on the internal electricity market) to prepare timetables for the implementation of 'intelligent metering systems', to achieve at least 80 % of consumers being equipped with such a system by 2020.[2] Since 2010, a substantial policy, technological and regulatory apparatus has been established, setting in motion the SMIP, ready for the rollout of 53 million residential and non-domestic gas and electricity meters (DECC, 2013a). The rollout is said to be '*one of the largest attempts to date to change consumer behaviour and represents a huge capital investment'* (Hill, 2015: 1) and '*the biggest energy industry change programme since the changeover to North Sea Gas*' (DECC, quoted in Darby, 2010: 448).

Energy suppliers are responsible for the rollout. Their role is to install smart meters and to engage householders into using them as outlined in DECC's Consumer Engagement Strategy (2012b) and communicated by the government body 'Smart Energy GB'. In the rollout, traditional gas and electricity meters are replaced by smart meters that can automatically send energy usage data through a mobile network to energy suppliers and receive instant information. In addition, householders are provided with an in-home display (IHD), a digital device that provides 'real-time' feedback on the amount of energy used in the home, and optional third-party 'Consumer Access Devices' (Pullinger et al., 2014). The technical specifications of smart meters were converted into the 'Smart metering equipment technical specifications' (SMETS) in 2012 (DECC, 2013b), and revised in 2014. SMETS have an important role in ensuring the interoperability of the infrastructure and devises, by setting minimum capabilities for all components, i.e. data collection, transmission and display technologies (Pullinger et al., 2014). As an example, "*SMETS 2 specifies that smart electricity meter data must be transmitted across the Home Area Network at a 'frequency better than 10 seconds', with a view to reducing this to 5 seconds in future, 'when technology improvements are evident'*" (Pullinger et al., 2014: 1155).

Several benefits and envisioned social changes have been associated with the rollout (e.g. Darby, 2010; Sovacool et al., 2017). Advocates have argued that smart meters engage consumers with their energy use through more frequent information, resulting in demand reductions, faster switching between suppliers, and energy cost reductions. Energy suppliers are said to benefit through reduced operating costs resulting from remote meter reading and more accurate bills (leading to fewer complaints) and the prospect of approved customer relations. Smart meters are also said to improve network efficiencies and avoid network reinforcements. In addition to shorter-term expected benefits, the rollout is also connected to longer-term expectations regarding the future electricity system based on the smart grid and possibilities for demand-side management (e.g., Darby and McKenna, 2012; Darby et al., 2013). They, in turn, are connected to a broader transformation of the electricity sector (e.g., Darby and McKenna, 2012; Darby et al., 2013; Verbong et al., 2013; Skjølsvold, 2014; Geels et al., 2015).

[2] EU Directive 2012/27/EU on energy efficiency explicitly defines a 'smart metering system' or 'intelligent metering system' to mean "an electronic system that can measure energy consumption, providing more information than a conventional meter, and can transmit and receive data using a form of electronic communication".

Academic literature has been critical about the role of smart meters in providing more efficient energy feedback and increasing consumer engagement (Darby, 2010; D'Oca et al., 2014; Nachreiner et al., 2015). Some academics have questioned whether the UK government's consumer aims will be met by the rollout (e.g., Darby, 2010; Pullinger et al., 2014; Hargreaves et al., 2013; Sovacool et al., 2017), considering the heavy reliance on consumers changing the ways in which they use energy. Geels et al. (2015: 42) have argued that the UK government '*provides only limited explanation as to how/why these energy savings will be brought about*'. Previous academic work has also focused on the details of the rollout, reflecting on deployment strategies (Jennings, 2013), the speed of adaption (Rixen and Weigand, 2014), possible policy developments (Darby, 2008), and privacy issues (McKenna et al., 2012). In addition, smart meters have been addressed in the literature on demand-side management (e.g., Fell et al., 2015) and smart grids (e.g., Faruqui et al., 2010; Römer et al., 2011). This paper complements the work of Skjølsvold (2014: 26), which examined *'future visions and expectations as they were formulated [in the smart meter policy debate]'* and their role in policy debates in Norway.

3. Conceptual background: Sociology of expectations

An extensive literature has developed under the notion of 'sociology of expectations' (see, e.g., van Lente and Rip, 1998; Brown, 2003, Borup et al., 2006) concerning novel science and technology ventures. The literature has concerned itself with examinations into how discourses at work in expectations for socio-technical innovations mobilise futures in the present. Frequently, expectations are referred to as '*real time representations of future technological situations and capabilities'* (Borup et al., 2006: 286). Recently, Konrad et al. (2017: 466) have proposed a '*broader and narrower'* definition, whilst including non-technical expectations, defining expectations as '*statements about future conditions or developments that imply assumptions about how likely these are supposed to be and that travel in a community or public space'.*

Borup et al. (2006: 268) have pointed out that expectations play a key role in representing desired futures '*by performing such futures, they are made real and in this sense expectations can be understood as performative*'. This role has been widely acknowledged in the sociology of expectation literature (e.g. Brown et al., 2003; Konrad et al., 2017). Rather than *'looking into the future'*, academics contributing to this literature advocate *'looking at how the future as a temporal abstraction is constructed and managed'* in the present (Brown et al., 2000). For them, such future-orientated discourses shape existing technological developments (such as the smart meter rollout) and collective sense making of future technological situations (Konrad et al., 2017). Expectations are said to play a crucial role in providing *'structure and legitimation*' (Borup et al., 2006: 286) within the emergence and stabilisation of socio-technical futures. Budde and Konrad (2015: 171) have argued that policy frequently follows expectations too closely when governing innovations, '*responding to the dynamics within the network of expectations when they occur*'.

3.1 Governance through expectations

Expectations can play a '*decisive role in 'governing', that is, coordinating and shaping innovation and transitions processes'*; yet, current work has concentrated less on how expectations are *'themselves "governed" in distinctive ways'* (Konrad, 2010: 1, 4; see also Bender, 2005; Geels and Raven, 2006). Konrad and Alvial Palavicino (2017: 190) has pointed two governance modes associated with expectations: (1) governance by expectations i.e. the

variety of different ways in which expectations contribute to the shaping, coordination, and legitimisation of innovation processes and (2) governance of expectations i.e. the ways expectations themselves are being articulated, adjusted and stabilised. This paper addresses both. It makes a claim that, first, expectations presented within policy documents contribute to the governing of innovation processes 'by expectations' by shaping innovation activities and legitimising certain innovations and not others (Figure 1). Second, over time, policy documents articulate, adjust stabilise expectations that have been presented by others and elsewhere in a more diverse form, thereby, also aiming to govern the expectations of multiple actors. These are interlinked through the influence they have on actors, and the expectations of and concrete innovation advocating activities performed by those actors. The approach proposed by Konrad and Alvial Palavicino (2017), and applied here, draws attention to the 'work involved in 'producing'' and managing expectations (Porter and Randalls, 2014: 204).

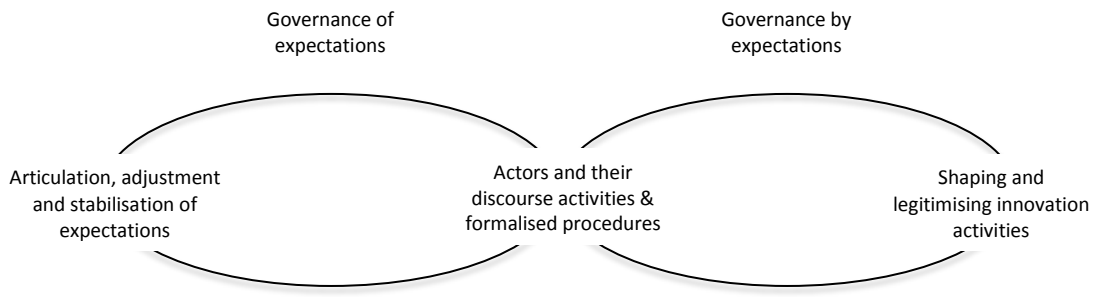

Figure 1: Visualisation: governance of and by expectations

Some studies have shown that actors consciously encourage and even inflate expectations surrounding a technology that they want to advocate (e.g., Brown et al., 2000; Bakker et al., 2012). Budde and Konrad (2015: 7, see also Bakker et al., 2012) have argued that policymakers are *'in a position of observers and possible "selectors" of expectations promoted by others'*. They select certain technologies over others and shape associated discourses that subsequently may also influence the choice of policy measures (Kivimaa and Mickwitz, 2011). Policymakers can also become 'enactors', spokespeople for particular expectations associated with an innovation, for instance, by setting up funding programmes for technologies (e.g., Budde and Konrad, 2015; Bakker and Budde, 2012). Berti and Levidow (2014: 142) found, whilst examining expectations related to the UK biofuel policy, that policymakers can become ''*promotors of technological expectations… aimed at primarily to maintain legitimacy towards technological innovators and Parliamentary critics'*. In these cases, policymakers articulate, adjust and stabilise expectations (e.g., Budde and Konrad, 2015) as well as aim to influence the expectations of others. Policymakers are, thus, involved in '*describing and prescribing an attainable and desirable future*' (Korsnes, 2016: 52, drawing on Jasanoff and Kim, 2009).

Expectations get articulated, persist and spread in various forms and shapes. They become ''*inscribed' in texts, actions, bodies, materials, objects, and machines*' (Borup et al., 2006: 292). Policy documents are one way in which expectations are rhetorically manifested (as studied, for instance, by Berti and Levidow, 2014). Policy documents can be seen as a record of the policy-making process (Huttunen et al., 2015), i.e. illustrating that expectations influence the set-up, continuation or de-continuation of policy instruments. The futures and expectations formulated in official policy documents are enacted by the mobilisation of

resources (Levidow et al., 2013), such as public funding for innovation and infrastructure development or human resources and private funding to implement regulations.

3.2 Articulation, adjusting and stabilisation of expectations over time

Several expectations as 'bids' about the future may be offered simultaneously by several actors (Berkhout, 2006). Actors compete '*for the right to represent near and far term developments*' (Brown et al., 2000: 5), articulating expectations and counter-expectations surrounding possible technological futures. Van Lente and Rip (1998) have suggested considering expectations as 'prospective structures', where expectations about future socio-technical structures might perform as if they had already been materialised. For Budde and Konrad (2015), expectations have a mediating role between materialised socio-technical structures and actors' visions of the future. Actors articulate and adjust expectations and associated 'prospective structures' with the hope to eventually influence the materialisation of actual structures (van Lente and Rip, 1998). Discourses play a key role in actors' exchange of expectations. In the process, expectations are '*consciously and subconsciously continuously adjusted to the specific expectations of other actors'* (Konrad, 2006: 431). Brown and Michael (2003) have, therefore, stressed the importance of the situated mapping of expectations to examine variations over time and between actors.

The exchange of expectations has been argued to be inherently political (Bryne, 2011), being a possible '*site of contestations*' (McEwan et al., 2014: 206). As argued by Budde and Konrad (2015: 148), drawing on Brown et al., 2000), '*actors try to 'colonize' by articulating expectations corresponding to a future desirable from their perspective*'. Moreover, McEwan et al. (2014: 206) state that '*who and what constructs futures will exclude some version to the advantages of others'* i.e. what kind of expectations and associated futures are enabled or constrained over time. The opportunities of alternative expectations being able to enter current representations of the future and the possible 'co-option' of these alternatives through 'powerful discourses' (Brown et al., 2000: 13) are key to the governance of expectations. Other viable, alternative futures may be neglected along the way.

Expectations can be 'tamed' and stabilised over time (Porter and Randalls, 2014) through conducting 'dedicated foresight, visioning, forecasting and technological assessment processes' (Konrad 2010: 1). Such activities are forms of more formalised construction of expectations. Networks of expectations can start to prevail and '*increasingly materialize in the governance field – including regulatory measures, support schemes and organisational structures – and with actors working actively towards stabilizing both prospective-discursive and the material structures*' (Budde and Konrad, 2015: 170). This does not necessarily mean that contestations no longer prevail and uncertainties are not kept alive, as 'techniques such as horizon scanning, scenario building, and futures visioning' (Wilkie and Michael, 2009: 506) can be inadequate (e.g. Brown et al., 2000).

Drawing on the above insights, we examine changes of expectations within policy documents i.e. mapping expectations over time and interrogating how policy has articulated, adjusted and attempted to stabilise expectations, whilst dealing with increasing scrutinising of the rollout. We examine, in particular, the governance through expectations to reflect on the role of policy documents in articulating and stabilising expectations and the associated technological futures.

4. Research approach and method

The main method of the study was policy document analysis, informed and complemented with academic literature review and four scoping interviews. Figure 2 outlines the three steps and 5 tasks of the research process.

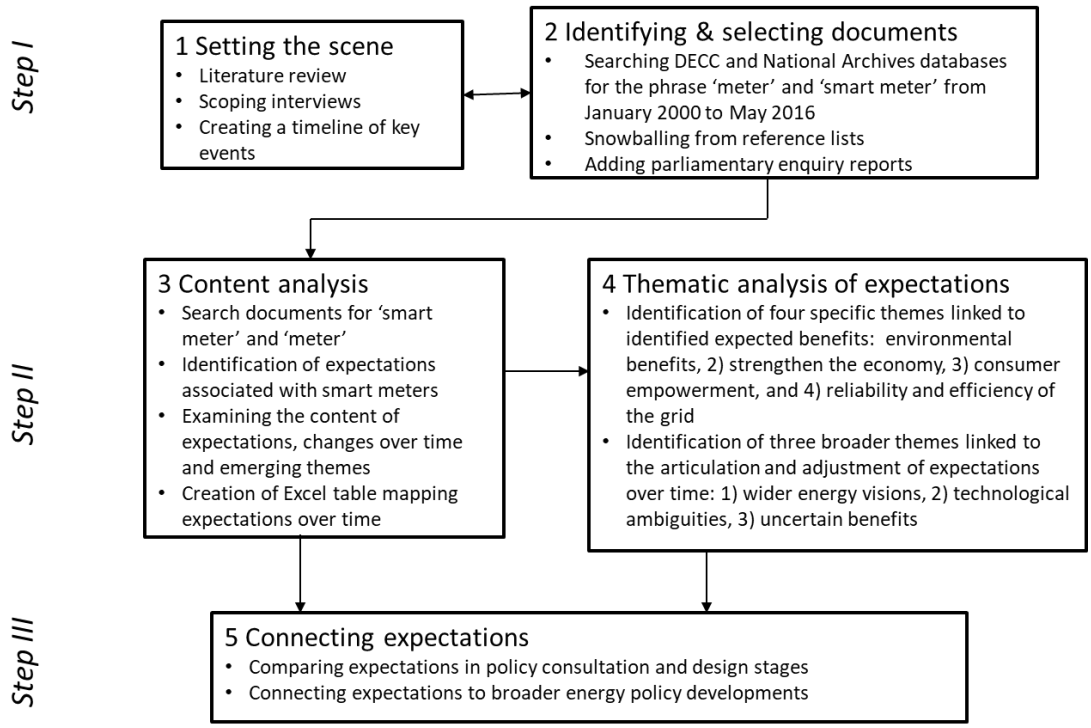

Figure 2: Visualisation of the research approach

In step I, to set the scene for the content analysis examining expectations in policy documents, four in-depth scoping interviews (an academic, a civil servant and two actors from non-governmental organisations) and a literature review were conducted to gain a historical perspective on the rollout and provide a context for our analysis. A timeline of key events and actions, such as pilots, impact assessments and consultations, was created to contextualise the governance of expectations (see Appendix A for a shortened version).

We searched for policy documents to record expectations in three sets of Command Papers, i.e., texts that set out and describe government initiatives: major policy proposals (such as White Papers), departmental reports and departmental reviews. These were identified by searching the Department of Energy and Climate Change and the National Archives databases for the phrase 'meter' and 'smart meter' from January 2000 to May 2016. Supplementary policy documents were added through a snowballing technique derived from reference lists of the initial pool of documents. Our search identified 49 documents, of which 38 mentioned smart meters and articulated surrounding expectations and were, thus, included in the analysis. Our search concentrated on 'higher level' policy documents, rather than ones specifically produced in relation to the smart meter rollout (such as smart meter consultation documents), because we wanted to examine expectations associated with smart meters within the wider energy policy debate. We also analysed five parliamentary inquiry reports surrounding the rollout that were produced, for instance, by the National Audit Office, and the Environment and Climate Change, the Science and Technology, and the Publics Accounts Committees during 2011–2016, and two departmental responses from the Department of Energy and Climate Change (DECC). The committees' role is to deliberate on policy issues, inspecting the work and expenditure of the UK government, whilst gaining

evidence from several sources. The inquiry reports therefore collect the views and arguments from several actors, such as academics, industry expects, and the public. Appendix B shows the full list of analysed policy documents and enquiry reports, totalling 43 documents.

In step II, qualitative content analysis of documents was conducted. Through an inductive approach searching the documents for the term 'smart meters' and 'meter', we identified 56 expectations linked to smart meters and positive future visions associated with them. We examined the content of expectations, the changes over time and what themes emerged. We, in particular, followed how the documents talked about the rollout, what kind of future promises were connected to them, and how technological choices, costs and dependencies with the broader policy mix were expressed. An Excel spreadsheet was created to map changes in the expectations over time (cf. Meyer and Avery, 2009, on Excel as a qualitative data analysis tool).

An inductive analysis revealed four specific themes that the expectations could be grouped under associated with the *expected future promises*: (1) environmental benefits, (2) consumer empowerment, (3) strengthening the economy, and (4) the reliability and efficiency of the grid (see Appendix C for a full list of expectations and four themes). It also indicated three broader themes that seemed to be at the centre of the policy debate, concerned with the *articulation* and *adjustment* of expectations over time: (a) connections to broader energy visions, (b) technological ambiguities, and (c) uncertain benefits. These themes correspond with Callon and Law's work about how technological advocates negotiate the 'relationships between context for a technological project and the content of the project' (Smith et al., 2014: 118, drawing on Callon and Law, 1989).

Step III was focused on comparing the expectations between the consultation phase (2000–2009) the policy design phase (2010–2016). Further, connections were made to broader energy policy developments in the writing up of the analysis.

The limitations of this research include that the analysis has mainly focused on policy and parliamentary documents, which is not representative of expectations derived from a broader set of actors i.e. '*larger sea of expectations'* (Konrad, 2006: 4; Truffer et al., 2008). While the parliamentary inquiry documents included the views of several actors, these may not represent all arguments and contestations. Further analysis of documents created, for instance, by energy companies, consumers groups and meter manufacturers would be required to gain a complete picture of the expectations dynamics and contestations associated with smart energy systems. However, this paper is one of the first to systematically analyse of changing expectations over time within policymaking at the policy design stage.

5. Analysis of expectations associated with the rollout

The empirical analysis looked at how expectations associated with the rollout were articulated and adjusted over a 16-year period (2000–2016), shedding light on the governance through expectations and linked contestations over time. Rather than outlining the four themes linked to the identified expectations (see, for instance, Stephens et al., 2014 work for a more in-depth description of some of these themes), this section outlines the three broader themes and links them to the ways in which expectations are articulated, adjusted and stabilised over time. The three empirical themes play a key role in the governance through expectations during this period: (1) broader energy visions, (2)

technological ambiguities, and (3) uncertain benefits. The analysis is organised into two time periods: the consultation phase (2000–2009) before the decision was made to rollout smart meters and the policy design phase (2010–2016).

5.1 Smart meter expectations: Broader energy visions

5.1.1 2000–2009: Smart meters, climate change and energy security

From 2002 onwards under the Labour government, UK energy policy placed more emphasis on the environment than ever before, as an attempt '*to be seen as a leader on climate change issues'* (Pearson and Watson, 2012). Formal climate change goals were set for the first time and outlined in the 2003 White Paper (DTI, 2003), highlighting the importance of energy efficiency and renewable energy. Follow up policy documents, such as the Energy Efficiency Implementation Plan (Defra, 2004), started to provide more details on how these goals could be met (Pearson and Watson, 2012). Smart meters were closely linked to these policy ambitions through being expected to enable emissions reductions and energy savings. Chapters on 'saving energy' made particular reference to smart meters, where they were said to deliver additional carbon savings (HM Government, 2006b: 36). They were believed to provide 'real-time' information about energy costs, and in the process, enable consumers to be more informed about their energy use and take action on it (e.g., HM Government, 2006a). In 2006, policy documents started to broaden expectations associated with smart meters by linking them to energy security issues:

> Smart meters can also be used with variable tariff structures for electricity consumption, for example, to discourage electricity use during peak periods. They can therefore contribute to improved energy security, as some network reinforcement and peak generation capacity could be avoided. (HM Government, 2006b: 48)

Energy security[3] joined climate change mitigation at the top of the energy policy agenda in 2007 under a re-elected Labour government, soon after rising criticism towards the UK government's '*relaxed approach about energy security*' (Pearson and Watson, 2012: 24). Energy efficiency and domestically produced small and large-scale '*renewables became the answer to both climate change and energy security objectives'* (Kern et al., 2014: 521). The expectation was that consumers would be able to *'become more flexible'* about their energy use (DTI, 2007: 108) through smart meters by using *'less energy at peak times'* (DTI, 2007: 64).

The UK Low Carbon Transition Plan (HM Government, 2009) outlined measures for how electricity generation could be decarbonised through low carbon energy supply. Smart meters were said to address these measures in several ways, firstly, by '*allow[ing] for more sophisticated import and export tariffs'* (DTI, 2007: 95) and in the process encouraging householders to become energy generators, and, secondly, by facilitating *'a more flexible grid'* that can deal with *'change in intermittent generation'* (HM Government, 2009: 170–71). Consumers were increasingly described in the policy documents as informed and flexible, leading to possible tensions in trying to accomplish both roles (see Darby, 2009).

5.1.2 2010–2016: Smart meters, cost savings and the low carbon economy

[3] Energy security has been defined by Cherp et al. (2012: 329) as *'protection from disruptions of energy systems that can jeopardize nationally vital energy systems'*. Availability, affordability, accessibility and acceptability have formed the key dimensions of energy security.

In 2010, a coalition government was put together between the Conservatives and Liberal Democrats. The new government continued to support the smart meter rollout and, through the broader energy policy discourse, it strengthened the role of consumers in the rollout. For example, one document stated that consumers are '*at the heart of everything we do'* (DECC, 2011a: 1). Smart meters were increasingly mentioned in combination with other policy instruments, such as the Green Deal (ended in July 2015) and the Energy Company Obligation (ended in April 2017), that focused on 'decarbonisation' issues (DECC, 2011b: 27). These policy instruments were said to offset increased energy costs through the greater uptake of renewable energy technologies and stimulate the development of new markets and innovations. Similarly, expectations associated with smart meters shifted from emphasising energy savings to cost savings. For instance, consumers needed to manage, monitor and control their energy use. Such efforts were linked with energy costs: *'control energy use, save money'* (DECC, 2012c: 35), and *'keep their bills down'* (DECC, 2014a: 13). The policy aim was to create a '*thriving, globally competitive, low carbon economy*' (DECC, 2012a: 6), where energy policy was meant to be delivered '*in a way that maximises benefits to the economy'* (DECC, 2012a: 6) whilst fairly distributing costs and benefits. From 2012, the smart meter was '*expected to deliver £7.2 billion in net benefits to the economy'* (DECC, 2012a: 6, 32). Such net benefits were connected to energy savings, but were also connected sporadically in the documents to costs savings for energy suppliers through the production of accurate bills that could be remotely read (DECC, 2012c). Policy documents started to emphasise that they wanted to put '*power in the hands of the consumer*' (DECC, 2014a: 21). The details on how consumers were supposed to achieve energy savings and reduced bills, beyond being more informed, were largely missing.[4]

Since 2012, smart meters have been increasingly linked to far-sighted expectations of a smart grid which smart meters are envisioned to enable. Such expectations were related to investments into UK energy infrastructure and the creation of a '*flexible, smart and responsive electricity system'* (DECC, 2011b: 5). During 2014-2015, under the newly elected Conservative government, two policy documents, 'Smart Grid Vision and Routemap' (DECC, 2014b) and 'Towards a smart energy system' (DECC, 2015), outlined these visionary expectations in more detail. This meant that expectations for smart meters were broadened even further and closely interlinked to visions for other technologies (e.g., electric vehicles), portrayed as an intermediate step for broader systemic innovation and the diffusion of modular innovations in low carbon economy.

What becomes apparent is that expectations through their articulation in policy documents have over time been linked and adjusted to changing policy goals (from climate change, energy security to low carbon economy) and narratives (for instance, customer at the heart of energy policy). The *broadening out of expectations*, associating smart meters with technologies to help customers to save energy, support energy security, and enable the smart grid, shaped the smart meter rollout in that it kept the SMIPs policy relevance alive whilst tensions in accomplishing different expectations prevailed.

5.2 Smart meter expectations: Technological ambiguities

5.2.1 2000–2009: Smart meter: Disputes over technological configurations

[4] This was still the case in November 2016, as observed by one of the authors during a 'Westminster Forum' event on smart meters on the 24th of November 2016, held in Whitehall, London. While there was a lot of talk how smart meters enable consumers to interact with the energy system, no information was provided on concrete actions that could help consumers to achieve energy savings.

During 2000–2005, the term 'smart meter' was hardly used in the policy documents. Reference was made to 'new types of meters' (DTI, 2003: 43), often mentioned only in passing (BERR, 2001: 73). At the time, metering technologies were diverse and whether a rollout would happen was uncertain. Several reports were produced that shed light on the varying expectations attached to metering and energy feedback technologies. The varying technological configurations were strongly linked to several (sometimes uncertain) expected benefits for consumers and energy suppliers, for instance, being able to manage their bills or producing accurate bills.

From 2004, smart meters became increasingly linked to the 'metering and billing' agenda (e.g., DTI, 2006: 37), encapsulating informative billing, tariffs and feedback devices to provide more efficient consumer energy feedback. The terms 'feedback devices' (HM Government, 2006a: 5) and 'real-time displays' (e.g., HM Government, 2006b: 47) were used interchangeably but in relation to different technologies, including pulse readers, optical readers, and magnetic field sensors. The 'metering and billing' agenda was partly driven by the EU Directive '*to ensure that energy consumers have frequent and informative billing, along with meters that reflect consumption accurately and provide information on time of use'* (Darby, 2008: 70). The directive aimed to provide better feedback information to energy users without suggesting which technologies to use to implement it (Darby, 2008).

Disputes arose between two government departments: the Department for Environment, Food and Rural Affairs (Defra), which advocated the supply of free, clip-on electricity real-time displays, and the Department for Business, Enterprise and Regulatory Reform (BERR), which promoted the rollout of smart meters (without feedback technologies) (Darby, 2008). Such disputes were mainly grounded in conflicting views on how to enable affordable and effective feedback mechanisms through differing technological configurations and gain expected benefits for consumers and energy suppliers.

In 2005, the Energy Efficiency Review (Defra, 2005) announced a set of government and utility funded pilots to look into a range of improved feedback technologies and the potential of achieving the expected benefits associated with certain technological configurations. In 2006, the UK government commissioned the Energy Demand Research Project (ERDF) trial, and work started a year later. Before the end of the trials, in 2007, the DTI White Paper (DTI, 2007: 64) stated, '*our expectation is that, within the next 10 years, all domestic energy customers will have smart meters with visual displays of real-time information*'. At this point, other technologies that provided consumer feedback were disregarded, and the government's expectation that energy savings (and therefore expected consumer benefits) would derive from the rollout of visual displays was substantiated, strengthening the links between rollout of displays and consumer empowerment narratives.

The requirement of visual displays lead to '*a storm of opposition, from the utilities and also from less predictable sources such as the energy consumer watchdog and a number of environmental organisations*' (Darby, 2008: 7). The government upheld their position until 2008, but then announced that visual displays would only need to be given to a 'particular customer segment' (Darby, 2008), keeping it open which feedback technologies would be rolled out. This position was kept in 2009, when the UK government's response to the consultation on smart metering was that '*the Government's position remains that a standalone display should be provided with the smart meter… the provision of a display is important to securing the consumer benefits of smart metering'* (Ministerial statement, 2009).

5.2.2 2010-2016: Smart meters: Continuing disputes

The term smart meter fully established itself in policy discourse from 2010 onwards. The SMIP started in 2010, setting out '*technical specifications for all data collection, transmission and display technologies'* (Pullinger et al., 2014: 1152) in the 'Functional Requirements' (DECC, 2011c, through numerous consultations). The full findings of the commissioned ERDF trials, carried out during 2007–2010 to study feedback technologies, had not been available to inform policy development during this period (Darby et al., 2011) and showed no statistically significant savings from smart metering monitors (Hargreaves et al., 2013). The expected energy savings from the rollout have rarely been mentioned since 2010 in the analysed policy documents, but have been anticipated to be 1–3% in the UK (rather than the previous mentioned 5–15%) (DECC, 2014c).

Although technical equipment standards started to materialise, earlier versions of the standards were interpreted by energy suppliers to permit them '*to offer consumers a choice of either an IHD [in-home display] or an alternative engagement tool'* (DECC, 2016: 5). Such interpretations demonstrate that the ways to provide energy feedback to consumers were still disputed and the achievement of associated expectations remained uncertain. In 2014, energy companies re-opened the debate around in-home displays, '*using the controversy about energy processes to call for a review of the costs of the smart-meter program and a replacement of expensive IHDs by cheaper apps on mobile phones or computers*' (Geels et al., 2015: 43). Further, the DECC launched a consultation in 2014 with the possibility to amend the 'Smart Meter In-Home Display licence conditions', and proposed further pilots to look into potentially cheaper technological alternatives.

The theme draws attention to how expectations were articulated and linked to a diverse set of technological configurations over time (from meters to smart meters with feedback device to smart meter with in-home display) within the policy documents. Over time, policymakers selected some technological configurations over others (for instance, particular types of feedback devices), attempting to stabilise the technological expectations. The choice of mandatory IHDs was legitimised through rhetoric of 'consumer at the heart of energy policy'. Although disputes over technological configurations persisted (and choices were not always based on results derived from pilots), policy documents attempted to *safeguard expectations* through developing detailed technical specifications of the technologies to be rolled out. These configurations are still disputed with earlier configurations being currently rolled out (i.e. SMETS 1) and later a later version being developed and piloted (SMETS 2).

5.3 Uncertain benefits

5.3.1 2000–2009: Smart meters: Recognised uncertainty of benefits

During 2000–2005, the expected benefits of smart meters were described as 'uncertain' in the policy documents (e.g., DTI, 2006: 31). In 2007, uncertainties were no longer voiced but rather turned into an expectation that '*within the next 10 years, all domestic energy customers will have smart meters with visual displays of real-time information that allow communication between the meter, the energy supplier and the customer*' (DTI, 2007: 64). This expectation was increasingly linked to the potential benefits of smart meters to create energy and carbon savings (e.g., DTI, 2007). These savings (and the benefits of smart meters) were set against the potential costs of rolling out smart meters.

Several actors (e.g., Mott MacDonald for BERR, 2007; and Lees for Energywatch, 2007) conducted analyses into the costs and benefits, considering a range of technologies and rollout speeds. Most reports stated that there are several uncertainties. For instance:

> There is some uncertainty regarding the meter equipment costs, given that none of the equipment has been produced in large numbers and technology is still evolving… There is much greater uncertainty on the benefits side, especially for energy savings. (Mott MacDonald, 2007: xiv).

It was also unclear how far energy suppliers would pass on cost benefits to consumers. Depending on the assumptions surrounding potential energy savings (associated savings) and metering functionality (and associated costs), the analyses derived differing results.

The policy documents similarly acknowledged that costs were estimated against little or no data on the implications of the rapid rollout. Still, some estimates were given ranging from '*serious implications for energy price, potentially increasing annual gas and electricity payments by £20 each for ten years*' (HM Government, 2006b: 48) to modest increases in energy prices and reduced bills if consumers act to realise energy efficiency savings (DTI, 2007). Many analyses concentrated merely on what level savings are or are not achieved, stating nothing about how savings are realised (e.g., Darby, 2009; Hargreaves et al., 2013). Further, questions that were raised such as '*how many benefits (and whose benefits) could be realised*' based on the various options and '*who might win or lose*' were hardly addressed (Darby, 2009: 459, 457; see also Engage Consulting, 2007).

5.3.2 2010–2016: Smart meters: Scrutiny of benefits

In 2010, the 'Prospectus for the Smart Metering Implementation Programme' (updated version, DECC, 2011c) was published, outlining delivery plans, a consumer engagement strategy and technical requirements. The programme moved from its 'policy stage' to the 'foundation stage', which meant more emphasis on building and testing the system and detailing consumer engagement (DECC, 2012b). A consumer communication body, Smart GB, was set up in 2013, and an Early Learning Project was carried out (DECC, 2015). The important role of smart meters to help meet key policy goals was stressed:

> The rollout of smart meters will play an important role in Great Britain's transition to a low-carbon economy, and help us meet some of the long-term challenges we face in ensuring an affordable, secure and sustainable energy supply. (DECC, 2012a: 32)

Rather than highlighting potential increases in costs, emphasis was increasingly placed on the net benefits derived from the rollout, starting from £7.2 billion over the next 20 years (e.g., DECC, 2012a) for the consumers, energy suppliers and networks. Such benefits derived from DECC's Impact Assessments (e.g., DECC, 2012). Only DECC's 2012 'Annual Energy Statement' mentioned how benefits occur through '*technologies that save consumers money*' and an associated '*market for smart energy services*' (DECC, 2012: 7,12). The smart meter was frequently linked to the Green Deal (since abolished), both being considered a *'multi-billion market'* (DECC, 2012: 7).

The policy documents provided a generally positive outlook on the smart meter rollout. Nevertheless, from 2011 onwards several parliamentary committees – the Energy and

Climate Change Committee (ECC, 2015b), Science and Technology Committee (STC, 2016), National Audit Office (NAO, 2011, 2014) and the Committee of Public Accounts (PAC, 2011, 2014) – started enquiries into the smart meter programme. These outlined several '*major risks'* (NAO, 2011), '*significant uncertainties over the estimated costs and benefits involved*' (PAC, 2011: 3), and '*the risk of falling far short of expectations*' (ECC, 2015b: 3), including the risks of rising costs because of the complexity of the rollout (NAO, 2014; PAC, 2014; ECC, 2015b), of consumers not being aware of the benefits (NAO, 2011, 2014; PAC, 2014; ECC, 2015b), of suppliers not passing on savings to the consumer (NAO, 2011; PAC, 2012), and of vulnerable customers losing out on benefits (NAO, 2011, 2014; PAC, 2012; ECC, 2015b).

DECC (and Ofgem) responded to the PAC (2011) enquiry in 2014 and the ECC (2015b) inquiry in 2015, arguing how '*building confidence and raising consumers' pre-installation awareness of smart meters'* and '*realis[ing] the benefits of smart meters'* will be made possible (ECC, 2015a: 9,11). A more recent SCT (2016) enquiry demonstrates that the programme was still being scrutinised, in particular based on costs and expected benefits, close to the implementation start date in autumn 2016, and that the achievement of expectations is still disputed.

The final theme draws attention to how expectations were articulated and adjusted related to several uncertainties of meeting the expected benefits (such as costs and energy savings) within the policy documents (from acknowledging uncertainties to stating net benefits and energy savings). Impact assessments of the expected costs and benefits were conducted by policymakers to *manage the uncertainties surrounding several expected benefits*. Although assessments have been conducted, they have been scrutinised by several parliamentary committees, putting into question some of the expected benefits associated the SMIP. Much legitimisation work is still needed although the rollout has already begun, including assessments and responding to scrutinisations to stabilise expectations and substantiate the rollout.

6. Discussion: Governance through expectations associated with the smart meter rollout

The focus of the paper has been the governance through expectations associated with the UK smart meter rollout. The empirical examination has revealed several ways in which expectations have been articulated, adjusted and stabilised over time, drawing attention to how the expectations have been broadened out and safeguarded, and how associated uncertainties have been managed over time. This section links the empirical examination back to the idea of policymakers as observers, selectors, promotors and enactors of expectations and associated technological futures (Budde and Konrad, 2015), in particular, discussing how policymakers do not only observe and select expectations through policy documents but also actively enact them through linked decisions regarding public resource use (Levidow et al., 2013) and policy instruments (Kivimaa and Mickwitz, 2011). An analysis of smart meter expectations shows how the SMIP, as a policy instrument, has secured its policy relevance over time, explicitly evident in how expectations are presented in the policy documents. Sub-sections 6.1-6.2 discuss the broadening out of, and safeguarding and managing uncertainties related to expectations, summarised in Table 1.

Table 1. Governance through expectations associated with smart meters over time

Articulating, adjusting and stabilising expectations	Governance by and of expectations: Policy documents shaping and legitimising innovation processes; and articulating, adjusting and stabilising expectations
Broadening out smart meter expectations	Enacting through securing the continuous policy relevance of smart meters • Broadening out expectations: Strong linkages between smart meter expectations and changing energy policy goals • Developing changing ideas of what smart meters can do/enable: 'Transformative performativity' of smart meters

	• Escalating commitments towards smart meter as a policy instrument • Continuing support for smart meters as a policy instrument even when the surrounding policy mix changes
Safeguarding smart meter expectations and managing associated uncertainties	Selecting technological configurations whilst ambiguities persist about how they will meet expected benefits Enacting through actively involved in legitimising the rollout by arguing for the credibility of existing expectations • Safeguarding expectations: Developing technical specifications • Managing uncertain expectations: Conducting impact assessments and pilots that have been scrutinised by the parliamentary committees • Creating narratives that strongly emphasise the benefits of consumers to reinforce the need for specific technological configurations • Deciding to rollout particular socio-technical configurations of smart meters, whilst technological configurations are still being re-configured and piloted, shaping technological trajectories of future smart systems

6.1 Broadening out smart meter expectations

Within the policy documents that act as devices of legitimisation and shaping, continuous connections have been made between shifting energy policy agendas and the changing expectations associated with smart meters, broadening the idea of what the technologies rolled out can do. For example, expectations have been extended from outlining the shorter-term benefits of smart meters, creating an informed consumer, to longer-term visions, such as smart meters as an enabler of a smart grid and associated, envisioned social changes. Such *'transformative performativity'* (Skjølsvold, 2014: 29) of the changing ideas of what smart meters can do has played a key role also in connecting smart meters to the shifting energy policy goals from climate change to energy security and low carbon economy.

The expectations placed on the technology in the policy documents have adapted to changing policy concerns – keeping smart meters 'alive' in the governance of energy innovation and maintaining a diverse set of expectations. Escalating commitments (i.e., several expected benefits were added to the chosen form of rollout (SMETS1&2) over time) justified the decision to roll out smart meters in the way planned even when faced with increasing scrutiny. Thus, SMIP has survived as a policy instrument, for instance, at a time when other instruments (such as the Green Deal) have been abolished (see, e.g., Rosenow et al., 2016). This raises questions about the dual role of smart metering as shaping the policy agenda (governance by expectations) and adapting to it by reframing itself (governance of expectations); with potential implications on the acceptability of innovations that do not cohere with the 'smart meter' vision. Simultaneously, little attention has been paid to how changes in the energy policy mix, i.e., removing policy instruments previously mentioned in connection to smart meters (Rosenow et al., 2016; Kern et al., 2017), will influence the expected futures.

As argued by Budde and Konrad (2015), policy actors do not only 'select' technologies and associated expectations. They also make them relevant throughout a changing policy environment by linking expected benefits to broader energy goals over time (i.e. enactors), whilst keeping the policy instrument alive.

6.2 Safeguarding smart meter expectations and managing associated uncertainties

Policy documents convert future-orientated expectations of a technology (van Lente, 1993) into technical requirements and, in the case of smart meters, this partly occurred before the results of the first pilots were published. The Energy Demand Research Project (ERDF) pilots in 2006, which Darby et al. (2011: 2,7) argued to produce '*a disjointed set of findings*', were published only after the rollout decision had been made. Thus, the first pilots had a

legitimising rather than a purely 'testing' role in governing the development of the smart meter system and related innovations in its components. Later on, the technical requirements (SMETS1), developed by DECC, safeguarded the expected benefits associated with the rollout (that were still highly disputed). Moreover, the design and specifications of smart meters, in combination with the in-home displays that were selected for the rollout of smart meters, were argued by DECC to be a crucial component for the achievement of expectations associated with consumer benefits, along with an in-depth understanding of energy feedback. The emphasis on consumer benefits became strongly connected to the broader energy policy discourse of putting '*the consumer… at the heart of everything we do'* (DECC, 2011a: 1), creating further greater policy relevance for the rollout and safeguarding associated expectations. This was an approach unlike to other European rollouts (see Darby, 2009).

Little attention has gone into how the smart meter (and display) will be used (or not) in the home, and whether they will bring about the expected changes. The policy documents seem to assume a predictable outcome of energy savings, despite the possible inefficiencies that the technologies might have in the future. Policy documents also outline technological futures in which consumers are seen to act rationally (i.e. reduce their energy costs when being informed) but pay little consideration to existing research concerned with the complexities of influencing everyday energy behaviour. The importance of these discussions has already been pointed out by several academics such as Darby (2009), Hargreaves et al. (2013), and Pullinger et al. (2014) throughout the consultation and policy design stage, but has not been picked up in the policy documents. As argued by Pullinger at al. (2014: 1158), '*the SMETS standards have been developed in a largely top-down industry-led process with little input from, or attention to the householder'*. The lack of consumer input into the technical specifications of smart meters seems to be at odds with narratives that state that consumer benefits are at the heart of the rollout. It seems that through maintaining the technological trajectory and associated expectations strongly linked to smart meters (in combination with an in-home display) achieving consumer benefits, other ways of providing feedback (Darby, 2006) and developing a 'smarter' energy grid (Rixen and Weigand, 2014; Bolton and Foxon, 2015) have been disregarded along the way.

In addition to pilot studies, impact assessments have been conducted from 2008 onwards, making a case for consumer benefits (mainly associated with energy savings). The expected costs and benefits have been highly debated (such as consumer savings), considering the first reactions to the 2008 impact assessment (Marres, 2012) and to the parliamentary committee enquiries since 2011 (see Section 5.3). A more recent Early Learning Project (a DECC programme carried out between 2012–2014) has provided some more detail on how to engage consumers, stressing the need for advice giving, knowledge exchange, and additional forms of feedback to gain energy savings (Darby et al., 2015). The question that might arise is how such a mechanism can still be built into the rollout, considering that the smart metering installation 'Code of Practice' was published in 2013.

Impact assessments, similarly to pilots, seem to do more than just trial and assess the effects of policy instruments by also attempting to manage associated uncertainties. Policy actors appear to contribute to the governance effort by deciding on the ways in which to assess the economic, social and environmental effects of smart meters and by developing technical specifications. In the case of smart meters, both are still highly contested. Policy documents create and signal commitments towards smart meters and help to maintain durable narratives linked to diverse expectations to justify the rollout. Such documents are part of

on-going legitimisation work, responding to continuing scrutiny of the expected costs and benefits associated with the rollout.

Policy actors (in part through policy documents but enforced through resource-based decisions) can play an active role in 'enacting' technological combinations and associated expectations. As argued by Bakker et al. (2012: 158), '*the distinction between enactors and selectors is analytically clear, but… actors that are selectors at one moment could act as enactors at another moment*'. This clearly seems to be the case for the UK smart meter rollout, where policy actors have selected technological configurations that continue to be highly disputed, enacting them through safeguarding the associated expectations and managing uncertainties, in particular how they have been presented in high level policy documents. Policy actors have, therefore, not only been spokespeople for particular future expectations associated with smart meters but seem to be actively involved in legitimising the rollout by arguing for the 'credibility' (Bakker et al., 2012: 1059) of existing expectations, whilst keeping particular technical configurations of the policy instrument alive and attempting to shape the ways in which socio-technical futures associated with smart systems are understood.

7. Conclusion

This paper examined the governance through expectations in the UK smart meter rollout, drawing on the sociology of expectations literature. The focus of this qualitative analysis was policy documents and parliamentary committee reports that were published during 2000–2016, and how they presented expectations.

Our empirical findings show that the policy relevance of smart meters has been maintained over time by actively governing the expectations associated with them. This has been possible, firstly, because of continuing connections made to shifting energy policy goals and visions, through the broadening out of expectations; secondly, assigning a diverse set of technological promises to smart meters, thus, enabling multiple expectations to survive over time even when some have become highly disputed, and; thirdly, developing persistent narratives of smart meters, such as 'empowering the consumer', that safeguard the expected benefits by linking them to pilots studies and impact assessments. In doing so, the policy documents have made use of expectations as a device to legitimise the implementation of smart meters (*governance by expectations*), while simultaneously paying less attention to (a) the scrutinisation of technological promises and expected benefits for consumers and (b) 'alternative futures' where consumer benefits are met through other means. The alternative futures have been disregarded by determining specific technological configurations (*governance of expectations*).

Our analysis brings to the fore that policy actors (through the production of policy documents) play an active role in the 'enaction' of technologies rather than purely being 'observers and selectors'. They are involved in the legitimisation work connected to the multiple expectations that can still go on during the policy design and implementation phase. Further, an analysis of the policy documents demonstrates how technological innovations are made relevant in the future when being linked to policy goals, even broadening technological expectations over time so that they keep their policy relevance. What also becomes apparent is what *does not* get enacted, and how these factors influence the *governance through expectations* and the rollout of smart meters. Furthermore, smart meters, by continuing to be on the policy agenda, influence future policy development in terms of what kind of future energy system is being pursued. Future work needs to look

more closely at the politics of being 'enactors' of technologies within policy beyond emerging technologies, not only analysing documents but also conducting interviews with policymakers who are involved within these processes. Such work could potentially uncover the politics behind safeguarding particular expectations and enacting technologies.

With regard to the SMIP, the analysis of policy documents shows the complexity of the British smart metering policy debate (cf. Lewis and Kerr, 2014) compared to many other European countries, where smart metering rollouts have been achieved in less complex ways. The studied policy documents have pre-assigned roles for several actors – in particular the consumer – thereby, developing prevailing narratives towards meeting consumer benefits, whilst paying little attention to the details of how they will be met. Further, they have created new institutional actors to deliver broader energy policy goals, such as energy efficiency and energy security, sometimes creating tensions between expectations and policy goals. Simultaneously, little attention is paid to how smart meters will achieve the expectations assigned to them in the transformation towards a low-carbon economy in a changing political and policy landscape, where most policy instruments that address energy efficiency and energy saving issues in UK homes have been removed.

Even though this analysis is based on a single case study, similar governance of expectations and associated technologies are likely to be found in other studies focused beyond emerging technologies. The UK smart meter rollout is a specific context in which to study the governance through expectations but it is not unlike other large infrastructure projects that are frequently characterised by uncertainties surrounding costs and benefits because of long planning horizons (see Flyvbjerg, 2007). This paper is a first step towards better understanding the significance of expectations within the governance of innovations beyond their emerging periods through policy documents.

To conclude, the importance of expectations in stipulating momentum for many science and technology innovations is widely acknowledged. While this study confirms the key role of expectations in innovation processes, it further draws attention to the importance of studying expectations not only at the time of emerging technologies but also, later on, during their implementation and what role do policy documents play in the governance of expectations. The investigation of processes seems to be key, considering that legitimisation work and scrutiny of expected benefits do not stop once the decision has been made to implement the technology.

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Appendix A: Timetable of key events and activities

Year	Activity/ Event	Phases
2001	Smart Meter Review Group	
2006	OFGEM consultation on smart meters	
2006	EU Energy End-Use Efficiency and Energy Services Directive	
2006	Government announced energy suppliers a pilot study of feedback devices such as 'smart' energy meters	
2006	Ofgem review: International experience of smart metering	
2007	Re-Election of Labour Party	2007 – 2010 Energy Demand Research Project
2007	Government consultation: Views on full roll-out of smart meters	
2009	DECC Impact Assessment of GB-wide rollout	
2009	Government consultation different implementation models	
2009	European Commission Directive 2009/72/EC	
2009	DECC announcement: Have smart meters in all home in Great Britain by 2020	
2010	Prospectus for the Smart Metering Implementation Programme (DECC)	2010-2011 Policy Design
2010	Coalition government put together: Conservatives & Liberal Democrats	
2011	Announcement: Start mass rollout in 2014 – Completion in 2019	
2011	Supplier start to install 'smart meters'	
2011	Energy Demand Research Project Final Analysis - OFGEM	
2011	National Audit Office (NAO) and Public Accounts Committee (PAC) carry out review	
2012	Consumer Engagement Strategy Consultation (DECC)	2011-2016 Foundation
2012	Public Accounts Committee (PAC) carries out second review	
2012	Monitoring and Evaluation Strategy (DECC)	
2012	SMETS 1 – Technical specifications	
2013	Launch of Smart Energy GB	
2013	Smart Meter Central Delivery (SMCDB) starts operation	
2014	Delay of smart meter rollout	
2014	Second enquiry from the National Audit Office (NAO)	
2015	Smart metering Early Learning Project: Synthesis report (DECC)	
2015	Energy & Climate Change Committee (ECC) enquiry & report on rollout	
2015	DECC Consultation on amendment of Smart Meter In-home Display licence conditions	
2015	Conservatives win general election	
2016	Science and Technology Committee (STC) enquiry & report on rollout	
2016	Start of main rollout	2016-2020 Main Installation

Appendix B: Full list of analysed policy documents

Publication year	Major policy proposals	Departmental reports	Departmental reviews	Parliamentary enquires
2001		Department for Business, Enterprise and Regulatory Reform (BERR): 'The UK Fuel Poverty Strategy'		
2003	Department of Trade and Industry (DTI): Energy White Paper 'Our Energy Future'			
2004		Department for Environment, Food and Rural Affairs (DEFRA): 'Energy Efficiency: The Government's Plan for Action'		
2005			DEFRA: 'Energy Efficiency Innovation Review'	
2006		HM Government: 'Climate Change: The UK Programme' DTI: 'Our Energy Challenge. Microgeneration Strategy'	HM Government: 'The Energy Challenge. Energy review'	
2007	DTI: A White Paper on Energy: 'Meeting the Energy Challenge'	Defra: 'UK Energy Efficiency Action Plan'		
2009		HM Government: 'The UK Low Carbon Transition Plan' Department of Energy and Climate Change (DECC): 'The UK Renewable Energy Strategy'		
2010		HM Government: 2050 Pathways Analysis DECC: 'Annual Energy Statement'		
2011	DECC: 'Planning our electric future: a White Paper for secure, affordable and low-carbon electricity'	DECC: 'UK Renewable Energy Roadmap' DECC: 'Microgeneration Strategy' DECC: 'Annual Energy Statement' DECC: 'Electric Market Reform'		National Audit Office: 'Preparations for the roll-out of smart meters'
2012		DECC: 'Energy Efficiency Strategy' DECC: 'Renewable Energy Roadmap' DECC: 'The future of heating' DECC: 'Energy Security Strategy' DECC: 'Annual Energy Statement' DECC: 'Electricity Market Reform'		House of Commons Committee of Public Accounts: 'Preparations for the roll-out of smart meters'
2013		DECC: 'A 2030 framework for climate and energy policies' DECC: 'UK Renewable Energy Road Map' DECC: 'Fuel Poverty Framework' DECC: 'Energy Efficiency Strategy' DECC: 'Annual Energy Statement'		
2014		DECC: 'The UK National Energy Efficiency Plan' DECC: 'Community Energy Strategy' HM Government: 'Meeting Carbon Budget' DECC: 'Smart Grid Vision and Roadmap'		House of Commons Committee of Public Accounts: 'Update on preparations for smart metering' DECC: 'Smart Metering Implementation Programme: Progress update report to the Public Accounts Committee'
2015		DECC: 'Towards a smart energy system'		House of Commons Energy and Climate Change

	DECC: 'Community Energy Strategy' DECC: 'A fuel poverty strategy for England' DECC: 'Electricity Market Design' DECC: 'Electricity Market Reform'	Committee (ECC): 'Smart meters: progress or delay?' Energy and Climate Change Committee (ECC): 'Smart meters: progress or delay?: Government and Ofgem Response to the Committee's Ninth Report of Session 2014-15'
2016		Science and Technology Committee (STC): 'Evidence Check: Smart metering of electricity and gas'

Appendix C: List of identified expectations

Expectations	Theme
1) Carbon savings 2) Drive uptake of RE 3) Reduce demand for heat 4) Support distributed and renewable energy generation 5) Move to electric vehicles	Environmental benefits
6) Bring down costs of pre-payment meters 7) Help consumer to budget 8) Increase energy efficiency awareness 9) Provide real time information on energy costs 10) Make energy use visible 11) Provide information to make informed choices 12) Energy bills accurate 13) Saving energy 14) Manage/ control energy use 15) Avoid wasting energy 16) Customers install micro-generation 17) Smoother switching between suppliers 18) Customers save money 19) Changing the way, we think about energy 20) Help vulnerable customers 21) Consumer more active role in the energy system 22) Reduce energy consumption 23) Turning off non-essential electrical appliances 24) Consumers take advantage of lower price periods 25) Better services from energy companies 26) Wide range of tariffs from suppliers 27) Suppliers to offer more cost-effective tariffs 28) One day switching	Consumer empowerment
29) Billion in net benefits to the economy 30) Remote meter readings, avoid home calls 31) Future innovation 32) Drive a more vibrant and competitive market 33) New products and services 34) Smarter energy market 35) Deployment smart appliances industry 36) Creation of jobs	Strengthening the economy
37) Energy networks plan and manage their activities 38) Access to a full range of energy management tools 39) Demand side management 40) Reduce peak loads via time of day tariffs 41) Network reinforcement and peak generation avoided 42) Advanced management techniques	Reliability and efficiency of grid

43) Automated demand side response 44) Consumers more flexible and responsive to market signals 45) Smart grid enabled by smart meter 46) Enhanced monitoring flow across the network 47) Deal with intermittence 48) Improved network efficiencies 49) Avoid the need to invest in additional network 50) Avoid the need to invest generation capacity 51) Generation capacity to meet peak demand 52) Incentives to use energy away at peak times 53) Reduce pressure on system 54) Network operators understand loads on infrastructure 55) Network operators plan investments 56) Network operators respond faster to supply loss	